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THE PHOTOCHEMISTRY OF THE FUTURE[1]

MODERN civilization is the daughter of coal, for this offers to mankind the solar energy in its most concentrated form; that is, in a form in which it has been accumulated in a long series of centuries. Modern man uses it with increasing eagerness and thoughtless prodigality for the conquest of the world and, like the mythical gold of the Rhine, coal is to-day the greatest source of energy and wealth.

The earth still holds enormous quantities of it, but coal is not inexhaustible. The problem of the future begins to interest us, and a proof of this may be seen in the fact that the subject was treated last year almost at the same time by Sir William Ramsay before the British Association for the Advancement of Science at Portsmouth and by Professor Carl Engler before the Versammlung deutscher Naturforscher und Aerzte at Karlsruhe. According to the calculations of Professor Engler Europe possesses to-day about 700 billion tons of coal and America about as much; to this must be added the coal of the unknown parts of Asia. The supply is enormous but, with increasing consumption, the mining of coal becomes more expensive on account of the greater depth to which it is necessary to go. It must therefore be remembered that in some regions the deposits of coal may become practically useless long before their exhaustion.

Is *fossil* solar energy the only one that may be used in modern life and civilization? That is the question.

[1] General lecture before the International Congress of Applied Chemistry, New York, September 11, 1912.

Sir William Ramsay has made a very careful study of the problem from the English point of view. He has considered the various sources of energy, such as the tides, the internal heat of the earth, the heat of the sun, water power, the forests and even atomic disintegration, and has come to the conclusion that none can be practically used in England on account of her special contour and climate.

Though the internal energy of the earth may produce terrible disasters through volcanic eruptions and earthquakes, it can hardly be used by man. The energy derived from the rotation of the earth (tides) can hardly be counted upon on account of the enormous quantities of water that would have to be handled. Atomic disintegration has recently been treated in a brilliant lecture by Frederick Soddy, with special reference to the enormous energy changes which are involved. If man ever succeeds in availing himself of the internal energy of the atoms, his power will surpass by far the limits assigned to it to-day. At present he is limited to the use of solar energy. Let us see, however, whether the *actual* energy may not supplant that stored up in fossil fuel. Assuming that the solar constant is three small calories a minute per square centimeter, that is, thirty large calories a minute per square meter or about 1,800 large calories an hour, we may compare this quantity of heat with that produced by the complete combustion of a kilogram of coal, which is 8,000 calories. Assuming for the tropics a day of only six hours sunshine we should have, for the day, an amount of heat equivalent to that furnished by 1.35 kg. of coal, or one kilogram in round numbers. For a square kilometer we should have a quantity of heat equivalent to that produced by the complete combustion of 1,000 tons of coal. A surface of only 10,000 square kilometers receives in a year, calculating a day of only six hours, a quantity of heat that corresponds to that produced by the burning of 3,650 million tons of coal, in round numbers three billion tons. The quantity of coal produced annually (1909) in the mines of Europe and America is calculated at about 925 million tons and, adding to this 175 million tons of lignite, we reach 1,100 million tons, or a little over one billion. Even making allowances for the absorption of heat on the part of the atmosphere and for other circumstances, we see that the solar energy that reaches a small tropical country—say of the size of Latium—is equal annually to the energy produced by the entire amount of coal mined in the world! The desert of Sahara with its six million square kilometers receives daily solar energy equivalent to six billion tons of coal!

This enormous quantity of energy that the earth receives from the sun, in comparison with which the part which has been stored up by the plants in the geological periods is almost negligible, is largely wasted. It is utilized in waterfalls (white coal) and by plants. Several times its utilization in a direct form through mirrors has been tried, and now some very promising experiments are being made in Egypt and in Peru; but this side of the problem is beyond my power to discuss and I do not propose to treat it here.

The energy produced by water power during the period of one year is equal to that produced by 70 billion tons of coal, according to the data given in Professor Engler's lecture. It is, however, very small, as might be expected, in comparison with the total energy that the sun sends to the earth every year. Let us now see what quantity of solar energy is stored by the plants: on the total surface of the various continents, which is 128 million

square kilometers, there is a yearly production of 32 billion tons of vegetable matter, which, if burnt, would give the quantity of heat that corresponds to the total combustion of 18 billion tons of coal. It is not much, but even this is 17 times as much as the total present production of coal and of lignite.

I

Now let us consider the first part of our subject. Is it possible or, rather, is it conceivable that this production of organic matter may be increased in general and intensified in special places, and that the cultivation of plants may be so regulated as to make them produce abundantly such substances as can become sources of energy or be otherwise useful to civilization? I believe that this is possible. It is not proposed to replace coal by organic substances produced by plants; but it is conceivable that this organic matter may be utilized more satisfactorily than is now the case.

It has frequently been said even by persons of authority that some day the transformation of coal into bread may become not only possible but economically desirable. According to these people the ideal of the future should be to produce through synthesis from coal all substances necessary for the alimentation of man: such substances as starch, sugar and fat, also proteins and perhaps cellulose; in other words to abolish agriculture altogether and to transform the world into a garden of useless flowers. Never was a greater fallacy thought or expressed: the real problem is just the reverse of this. My friend Professor Angeli wisely called to my attention that, while the externals of life have been changed greatly by the progress of industry so as to use all our technical knowledge to increase our comfort, the quality and quantity of human alimentation have hardly changed at all; nay, a new science has come into existence (bromatology) to see that no artificial product of industry enters harmfully into our alimentation. At the time of Napoleon III. an attempt was made to substitute gelatine for meat; but it was seen very soon—and now the reason for it is known by all—that this substitute could not be sufficient to maintain life. With the relatively small reserves of coal that the past geological epoch have stored for us, it will never be desirable to produce from coal what nature generously offers us through solar energy. It is on the other hand a work worthy of praise to attempt to make plants produce the fundamental substances in larger quantity. Modern agriculture tries to do this by intensive cultivation; but it is also desirable to make the plants store up solar energy and transform it into mechanical energy.

A well-known instance of this occurred when the development of the daily press in all civilized countries made it imperative to provide wood pulp in a sufficient quantity and at low prices. Trees better adapted to the purpose were soon found and they were those which, on account of their rapid growth, could furnish the necessary cellulose sooner. For the problem we are now considering the quality of the plants is of secondary importance; they may be herbs or trees; they may grow in swamps or dry places, on the sea coast or even in the sea; the essential point is that they grow fast or that their growth may be intensified. It would be like realizing the desire of Faust:

> Und Bäume die sich täglich neu begrünen!

Mephistopheles did not consider a similar task impossible:

> Ein solcher Auftrag schreckt mich nicht,
> Mit solchen Schätzen kann ich dienen.

Should we consider the task impossible, naturally in a more limited sphere, after so many centuries of culture? I do not be-

lieve so. The above estimate of the total production of organic matter over all the solid surface of the earth, that is, of 32 billion tons a year, has for its basis the old calculation of Liebig of 2.5 tons per hectare. This may be considered even to-day the average production for all the earth. According to A. Mayer, through intensified culture the production may be increased to 10 tons per hectare, and in tropical climates it may reach 15 tons. On a square kilometer it would be 1,500 tons, corresponding to 840 tons of coal, while the solar energy received in a year by a square kilometer would be equivalent to about 300,000 tons of coal, the part of the total energy stored up by the plants being about $\frac{1}{300}$. A great deal remains to be done, but if we consider that since Liebig, largely by adopting the methods proposed by him, the production has been at least quadrupled, we may hope to do much more in the future especially if we are spurred on by necessity or even by convenience.

By increasing the concentration of carbon dioxide up to an optimum value (1 to 10 per cent. according to Kreusler) and by using catalyzers, it seems quite possible that the production of organic matter may be largely increased, making use, of course, of suitable mineral fertilizers and selecting localities adapted to the purpose owing to the climate or the condition of the soil. The harvest, dried by the sun, ought to be converted, in the most economical way, entirely into gaseous fuel, taking care during this operation to fix the ammonia (by the Mond process for instance) which should be returned to the soil as nitrogenous fertilizer together with all the mineral substances contained in the ashes. We should thus get a complete cycle for the inorganic fertilizing substances, the only waste being that common to all industrial processes. The gas so obtained should be burnt entirely on the spot in gas engines and the mechanical energy thus generated should be transmitted elsewhere or utilized in any way that seems advisable. We need not go into details. The carbon dioxide, resulting from the combustion, should not be wasted but should be returned to the fields. Thus the solar energy, obtained by rational methods of cultivation, might furnish low-priced mechanical energy, perhaps better than through the systems based on mirrors, because the plants would be the accumulators of the energy received by the earth.

But the problem of the utilization of plants in competition with coal has another and more interesting side. First of all we must remember the industries which have their basis in agriculture: the cotton and other textile industries, the starch industry, the production of alcohol and of all fats, the distillation of wood, the extraction of sugar, the production of tanning substances and other minor industries. All these industries are susceptible of improvement not only by the introduction of more advantageous technical devices in the treatment of the raw materials but also by a largely increased production of the raw materials. Let us think for an example of the progress made in the production of beet sugar.

The plants are unsurpassed masters of —or marvellous workshops for—photochemical synthesis of the fundamental substances, building up from carbon dioxide with the help of solar energy. They also produce the so-called secondary substances with the greatest ease. These latter are usually found in the plants in small quantity and are of value for special reasons. The alkaloids, glucosides, essences, camphor, rubber, coloring substances and others are of even greater interest to the public than the fundamental substances on account of their high commercial value.

In this field a battle is raging between chemical industry and nature, a battle which does honor to human genius. Up to now the products prepared from coal tar have almost always been triumphant. I do not need to remind you of the various victories; but it is possible that these may prove to have been Pyrrhic victories. A great authority on organic industries considered recently what would happen in case, for any reason, there were a rapid increase in the price of coal tar and consequently of the substances contained in it. He pointed out the inevitable effect of this on the coal tar industries. We all remember with admiration the story of the great difficulties that had to be met in the choice of the raw material for the production of indigo. It was necessary finally to use naphthalene because toluene could not be obtained in sufficient quantity. But it is not merely through a rise in the price of the raw materials that an industry may suffer; it may be brought to a standstill by a diminished interest and activity in a certain field of scientific study. It has been thoroughly established that modern industry is affiliated very intimately with pure science; the progress of one determines necessarily that of the other. Now the chemistry of benzene and its derivatives does not constitute the favorite field of research as it did during the second half of the last century. The center of interest is now to be found in the matters and problems connected with biology. Modern interest is concentrated on the study of the organic chemistry of organisms. This new direction in the field of pure science is bound to have its effect on the technical world and to mark out new paths for the industries to follow in the future.

It is a fact that lately several organic industries have been successfully developed, outside of the field of benzene and coal tar. There are flourishing industries in essences and perfumes and in some alkaloids, like coca. In these industries products, which plants produce in relatively large amounts, are converted into products of higher commercial value. For instance everybody knows that essence of violet is now made from citral contained in lemon oil. This is a line along which we ought to follow because we are certain of making progress. It is to be hoped that in the future we may obtain rubber commercially in some such way.

The question has still another side, which I believe deserves your attention; it concerns certain experiments recently made by myself together with Professor Ravenna at Bologna. It is not because we have arrived at any practical results that I refer to these experiments; but because they show definitely that we can modify to a certain extent the chemical processes that take place during the life of the plants. In a series of experiments made in an effort to determine the physiological function of the glucosides, we have succeeded in obtaining them from plants that usually do not produce them. We have been able, through suitable inoculations, to force maize to synthesize salicine. More recently, while studying the function of the alkaloids in the plants, we have succeeded in modifying the production of nicotine in the tobacco plant, so as to obtain a large increase or a decrease in the quantity of this alkaloid. This is only a beginning, but does it not seem to you that, with well-adapted systems of cultivation and timely intervention, we may succeed in causing plants to produce, in quantities much larger than the normal ones, the substances which are useful to our modern life and which we now obtain with great difficulty and low yield from coal tar? There is no danger at all of using for in-

dustrial purposes land which should be devoted to raising foodstuffs. An approximate calculation shows that on the earth there is plenty of land for both purposes, especially when the various cultivations are properly intensified and rationally adapted to the conditions of the soil and the climate. This development is the real problem of the future.

II

Technical organic industry may yet expect great help from photochemistry understood in the sense above expressed and the competition between this and the chemistry of coal tar will be a great incentive for new progress. It is also true that human genius will always tend to proceed along lines selected by itself, and there is no question but that the great development in the coal tar industry has been due in part to this splendid spirit of independence. It may be asked whether there are not other methods of production which may rival the photochemical processes of the plants. The answer will be given by the future development of photochemistry as applied to the industries and on this I have a few ideas to express. The photochemical processes have not had so far any extensive practical application outside of the field of photography. From its very beginning photography has aroused a great deal of interest; it was taken up technically and, as usually happens in similar cases, it had a rapid and brilliant success. But notwithstanding the many applications photography represents only a small part of photochemistry. So far, photochemistry has only been developed to a very slight extent, perhaps because chemists have been attracted by problems which seemed more urgent. So it happens that while thermochemistry and electrochemistry have already reached a high degree of development, photochemistry is still in its infancy. Now, however, we notice a certain awakening due to a series of studies concerning general problems and special processes, especially in the organic field, in which my friend Dr. Paul Silber and myself have taken an active part. Two recent publications, one by Plotnikow and the other by Benrath, bear witness to this. But much remains to be done both in theoretical and general photochemistry as well as in the special branches.

The photochemical reactions follow the fundamental laws of affinity, but have a special character. They are especially notable for the small temperature coefficient and are, however, comparable—a fact which is not without technical importance—to the reactions which take place at very high temperatures. According to a brilliant idea of Plotnikow, luminous radiations produce a different ionization from that due to electrolytic dissociation; the separation of an ion requires a quantity of light which is determined by the theory of Planck and Einstein. The question is therefore related to the most recent and profound speculations of mathematical physics.

For our purposes the fundamental problem from the technical point of view is how to fix the solar energy through suitable photochemical reactions. To do this it would be sufficient to be able to imitate the assimilating processes of plants. As is well known, plants transform the carbon dioxide of the atmosphere into starch, setting free oxygen. They reverse the ordinary process of combustion. It has always seemed probable that formaldehyde was the first product of the assimilation; and Curtius has at last demonstrated its presence in the leaves of the beech trees. The artificial reproduction of a similar process by means of ultraviolet rays has already

been obtained by D. Berthelot. With convenient modifications could not this now actually be done on the tropical highlands? Yet the true solution consists in utilizing the radiations that pass through the entire atmosphere and reach the surface of the earth in large amounts. That a way of accomplishing this exists is proved by the plants themselves. By using suitable catalyzers, it should be possible to transform the mixture of water and carbon dioxide into oxygen and methane, or to cause other endo-energetic processes. The desert regions of the tropics, where the conditions of the soil and of the climate make it impossible to grow any ordinary crops, would be made to utilize the solar energy which they receive in so large a measure all the year, that the energy derived from them would be equal to that of billions of tons of coal.

Besides this process, which would give new value to the waste products of combustion, several others are known, which are caused by ultraviolet radiations and which might eventually take place under the influence of ordinary radiations, provided suitable sensitizers were discovered. The synthesis of ozone, of sulphur trioxide, of ammonia, of the oxides of nitrogen, as well as many other syntheses, might become the object of industrial photochemical processes.

It is conceivable that we might make photoelectrical batteries or batteries based on photochemical processes, as, for instance, in the experiments of C. Winther.

Passing to the field of organic chemistry, the reactions caused by light are so many that it should not be difficult to find some which are of practical value. The action of light is especially favorable to processes of reciprocal oxidation and reduction which give rise to or are associated with phenomena of condensation. Since the common condensation is that of the aldolic type there is much hope for the future, the aldolic condensation being the fundamental reaction of organic synthesis. Some experiments recently made by my friend Silber and by myself may serve here as an illustration. The simplest case is that of the action of light on a mixture of acetone and methyl alcohol in which

$$\begin{array}{l} CH_3 \\ | \\ CO \\ | \\ CH_3 \end{array} + CH_2OH{=}\begin{array}{l} CH_3 \\ | \\ COH \\ | \\ CH_3 \end{array}{-}CH_2OH$$

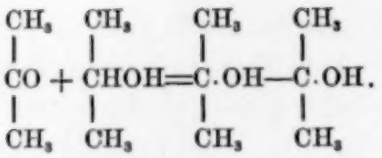
isobutylene glycol is produced. But this condensation which may be considered as a simultaneous process of oxidation and reduction, is accompanied by the reduction of the ketone to isopropyl alcohol and by the oxidation of the methyl alcohol to formaldehyde, which latter, however, does not remain as a product which can be isolated, because it reacts with the remaining methyl alcohol and is transformed into ethylene glycol:

$$\begin{array}{l} CH_3 \\ | \\ CO \\ | \\ CH_3 \end{array} + 2CH_3OH \rightarrow \begin{array}{l} CH_3 \\ | \\ CHOH \\ | \\ CH_3 \end{array} + \begin{array}{l} CH_2OH \\ | \\ CH_2OH. \end{array}$$

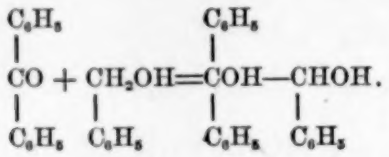
Applying the same photochemical reaction to the mixture of acetone and ethyl alcohol we have analogous products: trimethylethylene glycol; and along with this isopropyl alcohol and dimethylethylene glycol:

$$\begin{array}{l} CH_3 \\ | \\ | \\ | \\ C{\cdot}OH{-}CH{\cdot}OH \\ | \quad | \\ CH_3 \quad CH_3 \end{array} \text{ and } \begin{array}{l} CH_3 \\ | \\ CHOH \\ | \\ CHOH. \\ | \\ CH_3 \end{array}$$

With acetone and isopropyl alcohol, as could be expected, there is formed only pinacone:

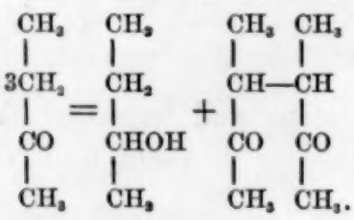


In the aromatic series benzophenone and benzyl alcohol give triphenylethylene glycol, together with other products:



This was the first case in which this condensation has been observed; others were afterwards studied by Paternò, who replaced the benzyl alcohol by several other aromatic substances. The observations of Klinger showed that the aldehydes also underwent condensations, and this has since been confirmed by Benrath.

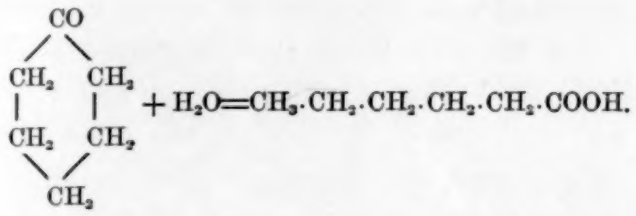
To get an idea of the variety of photochemical reactions we may confine ourselves to a systematic study of the ketones and alcohols. In ordinary organic chemistry the reactions often take place in some definite way; but the photochemical reactions often furnish surprises and proceed along quite different lines. From the very first experiments we knew that benzophenone did not form addition products with ethyl alcohol, but was converted into pinacone at the expense of the alcohol, which was oxidized to aldehyde. Proceeding with the study of aliphatic ketones, similar to acetone, we have this year discovered a remarkable fact. Methylethylketone condenses with itself and forms the paradiketone, reducing itself at the same time to secondary butyl alcohol:



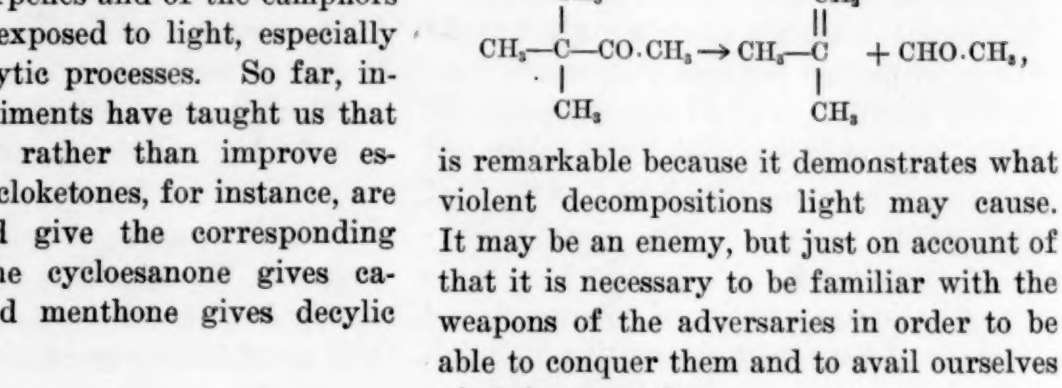
Of course the synthesis of diketones by light could not be an isolated reaction; we had previously noticed the formation of diacetyl: acetonylacetone is found, as we now know, among the products of acetone in solution in ethyl alcohol and it is also possible that the metadiketones, such as acetylacetone for instance, may be prepared photochemically. These reactions have a special importance on account of the special character of the diketones and their tendency to change in all sorts of ways. From them derivatives of benzene can be obtained as well as of pyrrazol and isoxazol, of quinoline, of furfurol, of thiophene and of pyrrol. In regard to this last change I wish to remind you that tetramethylpyrrol corresponds to the paradiketone previously referred to. If I dare to be reckless, as you may see I am at this moment, contrary to my custom, but perhaps urged thereto unconsciously by the American genius which heeds no obstacles, I may refer to the relations between the polysubstituted pyrrols with alcohol radicals and chlorophyll, and I may see in these reactions the possibility of the synthesis of this fundamental substance by means of an artificial photochemical process. Its formation in plants, like its function, is due to a photochemical process; we do not know, however, whether and in what measure light enters into all the synthetic plant reactions, from which originate the various substances which we find in plants. The research should proceed together in the two fields; phytochemistry and photochemistry will be of great help one to another. Industrially this cooperation might have a great future: the raw materials obtained from the plants might be refined through artificial photochemical processes.

Lately we have been interested intensely by the changes that some substances of the

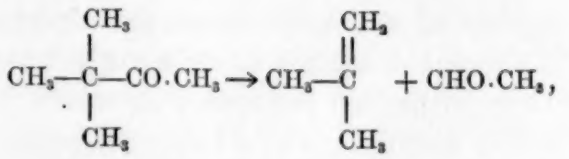
group of the terpenes and of the camphors undergo when exposed to light, especially through hydrolytic processes. So far, indeed, our experiments have taught us that light can spoil rather than improve essences. The cycloketones, for instance, are hydrolyzed and give the corresponding fatty acids; the cycloesanone gives capronic acid and menthone gives decylic acid.



In photochemistry, however, one reaction does not exclude the other; the reactions may be reversed as some recent experiments with ultraviolet rays demonstrate; for the ultraviolet rays sometimes reverse reactions caused by less refrangible radiations. It is important to find suitable sensitizers and catalyzers. We can see what the future has in store for us from such reactions as the photolysis of the ketones, which often accompanies the hydrolysis, and by means of which we prepare isocitronellal, for instance from menthone,



or the transformation of camphor into an unsaturated cycloketone, etc. The analogous breaking down of pinacoline into butylene and acetic aldehyde,



is remarkable because it demonstrates what violent decompositions light may cause. It may be an enemy, but just on account of that it is necessary to be familiar with the weapons of the adversaries in order to be able to conquer them and to avail ourselves of their strength.

I do not believe, however, that the industries should wait any longer before taking advantage of the chemical effects produced by light. The polymerizations, the isomeric changes, the reductions and oxidations with organic and inorganic substances, and the autoxidations which light causes so easily should already find profitable applications in some industries if researches were carried out carefully with this in mind. The action of light on nitric and nitrosilicic compounds, as we know it from experience, is one that ought to be utilized profitably. Our own transformation of orthonitrobenzoic aldehyde into nitrosobenzoic acid has recently been studied by various chemists, and has been made use of by Pfeiffer, who prepared a nitrophenylisatogen from chlorodinitrostilbene. This reminds us of the not less known transformation of benzylidene orthonitroacetophenone into indigo by Engler and Dorant and makes us foresee a new field in the photochemical pro-

duction of artificial colors and dyestuffs. The scope of studies on this subject ought not to be limited to preserving colors from fading, bleaching and all changes produced by light. The photochemistry of colors and dye-stuffs ought to furnish new methods of preparation and of dyeing. Very encouraging experiments have already been made with diazoic compounds and mention should be made of the recent observation of Baudisch that α-nitrosonaphthylhydroxylamine is changed on the fiber to azoxynaphthalene when exposed to light. The autoxidation of leuco compounds by light is an old practise of which the ancients availed themselves for preparing purple; now the process is explained, thanks to the familiar researches of Friedländer, but it is clear that a great deal remains to be learned in this field.

Phototropic substances, which often assume very intense colors in the light, and afterwards return in the darkness to their primitive color, might be used very effectively. Such substances might well attract the attention of fashion rather than fluorescent materials which give the impression of changing colors. The dress of a lady, so prepared, would change its color according to the intensity of light. Passing from darkness to light the colors would brighten up, thus conforming automatically to the environment: the last word of fashion for the future.

Solar energy is not evenly distributed over the surface of the earth; there are privileged regions, and others that are less favored by the climate. The former ones would be the prosperous ones if we should become able to utilize the energy of the sun in the way which I have described. The tropical countries would thus be conquered by civilization, which would in this manner return to its birthplace. Even now the strongest nations rival each other in the conquest of the lands of the sun, as though unconsciously foreseeing the future.

Where vegetation is rich, photochemistry may be left to the plants and by rational cultivation, as I have already explained, solar radiation may be used for industrial purposes. In the desert regions, unadapted to any kind of cultivation, photochemistry will artificially put their solar energy to practical uses.

On the arid lands there will spring up industrial colonies without smoke and without smokestacks; forests of glass tubes will extend over the plains and glass buildings will rise everywhere; inside of these will take place the photochemical processes that hitherto have been the guarded secret of the plants, but that will have been mastered by human industry which will know how to make them bear even more abundant fruit than nature, for nature is not in a hurry and mankind is. And if in a distant future the supply of coal becomes completely exhausted, civilization will not be checked by that, for life and civilization will continue as long as the sun shines! If our black and nervous civilization, based on coal, shall be followed by a quieter civilization based on the utilization of solar energy, that will not be harmful to progress and to human happiness.

The photochemistry of the future should not however be postponed to such distant times; I believe that industry will do well in using from this very day all the energies that nature puts at its disposal. So far, human civilization has made use almost exclusively of fossil solar energy. Would it not be advantageous to make better use of radiant energy?

Giacomo Ciamician

Bologna

THE FIRST INTERNATIONAL EUGENICS CONGRESS

THE First International Eugenics Congress was held at the Imperial Institute (University of London), South Kensington, July 24, to 30, 1912. It was an outgrowth of the work of the Eugenics Education Society of England. So far as the writer is informed, the latter was the first distinct organization to be formed for the definite purpose of advancing the eugenics propaganda. It was, therefore, fitting that the first call for an international conference to discuss the problems of eugenics should emanate from this body.

The congress was a great success from every point of view. Locally it evidently helped the cause a great deal, because of the demonstration which it gave of the world-wide interest which exists in regard to eugenics. With such men in personal attendance as Professor Yves Delage, M. Lucien March, Directeur de la Statistique Générale de France, M. Paul Doumer, sometime President of the Chamber of Deputies, His Excellency General von Bardeleben, President of the Verein Herold of Berlin, Professor A. C. Haddon and Professor R. C. Punnett of Cambridge, and Professor F. C. S. Schiller of Oxford, it was evident to the most casual consideration that the eugenics movement possessed that quality of "respectability" which is dearest to the British official heart. From an international point of view the congress gave the opportunity, for which the time was ripe, for a full discussion of eugenic problems as they appear in different civilizations and communities.

The administrative details connected with the preparation for the congress and the carrying of it through were worked out in a thoroughly excellent manner. The way in which the congress was managed, and the smoothness with which the machine ran, were matters of universally favorable comment among those present. The credit for this belongs in the first instance to the honorary secretary, Mrs. Sybil Gotto.

The attendance was large—much larger indeed than any one had anticipated beforehand. Up to the day before the close of the congress 836 persons had registered. Besides these there were many who attended as daily visitors. The papers presented were, taken as a whole, of excellent quality. There was an almost entire absence of the sensationalism, and hasty generalization as to the solution of fundamental social problems, which had been in greater or less degree expected by the general public. The majority of the papers fell in the field of what might be called "practical" eugenics. No attempt was made towards a technically scientific congress. Such a policy would have been obviously unwise. Eugenics is distinctly an *applied* science. Hitherto everybody except the scientist has had a chance at directing the course of human evolution. In the eugenics movement an earnest attempt is being made to show that science is the only safe guide in respect to the most fundamental of social problems. In order to make this attempt amount to anything practically it is obvious that the man of affairs, the legislator, and the administrator must not be alienated by technicalities beyond his comprehension. If science wishes to lead, she must speak the same language as those she expects to follow her.

Despite the generally popular and practical character of the papers, there were a number presented which were of particular scientific interest and made distinct contributions to knowledge. Dr. Soren Hansen, of Denmark, showed that during the period since 1852 there has been an increase in the average height of adult Danes of 3.69 cm. He is of the opinion that the same thing has been true of other North European peoples. Professor Antonio Morro presented some interesting new statistical data regarding the influence of the age of parents on the psycho-physical characters of the children, tending to show that relatively young and relatively old parents produced a larger proportion of degenerate offspring than parents of medium age. M. Lucien March contributed a detailed analysis of French statistics on the relation of social status, social surroundings and income to the fertility of marriage. His results confirm and extend those of earlier studies in this field.

Dr. Frederick Adams Woods summarized the results of unpublished studies which he has made in historiometry, showing the preponderant influence of heredity in influencing the course of history. Professor Corrado Gini contributed a long paper dealing with the evidence obtained from demographic statistics on certain eugenic problems. The paper was a decidedly interesting one but impossible of brief review. Professor F. C. S. Schiller's paper on "Practicable Eugenics in Education" was an exceedingly keen analysis of the significance, from the standpoint of eugenics, of the existing educational system of England.

The social side of the congress was one of its most pleasant features. The hospitality committee, under the chairmanship of Mrs. Alec. Tweedie, arranged a series of banquets, receptions, teas, garden parties and excursions which made it possible for the members of the congress to meet not only one another, but also many of the most distinguished persons in English scientific, social, literary and public life.

Raymond Pearl

INDUSTRIAL EDUCATION IN THE PHILIPPINES

Under the leadership of American educators, Philippine education is making a remarkable advance. Indeed, according to recent reports received at the United States Bureau of Education, there are features of present-day education in the Philippines that are well worth the careful attention of school leaders in the United States.

It is in the field of industrial training and useful arts that the Filipinos, under American teachers, are making the most notable progress; such progress, in fact, that in certain lines—particularly lace-making and embroidery—the products of the Philippine schools not only compare favorably with the work of the famous French and Swiss experts, but promise to compete with them successfully in the world's markets.

The whole system of education in the Philippines is based on the principle that the children should receive training that will prepare them directly for the life they are to live. The boys receive manual training from the very beginning. In the lowest grades they make articles that they can use and sell, both in their own localities and elsewhere. The most important industry taught the boys is hat-weaving. It is a prescribed exercise in the primary schools. "The Bureau of Education at Manila considers it one of its legitimate functions to give such training in the making of good hats as will afford a large number of children a permanent means of earning a livelihood," wrote Mr. Frank R. White, Director of Philippine education, in 1910, after the courses had been introduced, and the development of the work has more than justified his claim. Chief among the products are the famous "buntal" hats, made from the leaf stem of the opened buri leaf. The schools do not attempt to replace hand machinery with modern apparatus, for it is recognized that there is a real demand for the products of careful handworkmanship. Besides the prescribed courses in the primary schools, there are regular grade schools, where the boys spend the greater part of the school-day in actual manual labor in the shops. A set of dining-room furniture in red narra, made at the Philippine School of Arts and Trades in Manila, sold for $200 at last year's carnival.

In the girls' schools plain sewing and housekeeping have generally formed the prescribed courses, but recently lace-making and embroidery have been introduced because they are arts which, besides possessing educational value, furnish the girls with a remunerative occupation. There were already in the Philippines young women who had learned embroidery and lace-making in the convents under the Spanish régime. Furthermore, because of their great natural aptitude for such work, and because of their patience and delicacy of execution, the Filipino women are considered among the most skilful workers in the world in these arts, their products being classed by experts as even superior to that of the French and the Swiss. The schools are, therefore, working on sure ground in teaching

lace-making and embroidery, and they have ascertained that the demand for the kind of work their children can turn out is practically unlimited. In an effort to increase the available supply of teachers for the work, courses in lace-making and embroidery have been offered in the Philippine Normal School since 1910, and also in the various vacation assemblies of teachers.

The first thing a Filipino girl does in the sewing class in school is to make for herself a complete outfit of clothing. This work she usually begins in the second grade, but sometimes in the first or third. Armed with an embroidery frame and other apparatus (in most cases made by the boys in the same school), she advances in proficiency through the various grades; hemming and embroidering cotton squares, fine linen, handkerchiefs, waists, and so on. The more expert girls turn out masterpieces in French net and embroidery. In lace they make all varieties of "pillow lace," including "torchon" (Spanish lace), Maltese, Ceylon or Indian, Irish crochet, etc. Battenburg is also made for local use, but it is not encouraged for export, because the Japanese can make it more cheaply.

An idea of the extent of industrial education in the Philippines may be gained from the fact that nearly 400,000 school pupils are engaged in some kind of industrial work. For the past four years industrial instruction has been prescribed in the primary course for both boys and girls, and the work is systematically carried on in an advanced stage in the intermediate schools. Twenty-six well-equipped trade schools have been established in Manila and the various provinces; there is a college of agriculture at Los Banos, and a college of engineering has been added to the University of the Philippines. The Filipinos take to the educational program, industrial and otherwise, quickly and profitably; and the civil government finds its duties much less onerous now that the military invasion of the islands has been superseded by the educational.

GRADUATES FROM AMERICAN COLLEGES AND UNIVERSITIES

THE Boston *Transcript* has printed an article by Mr. Henry T. Claus, who gives the number of degrees conferred by 47 colleges and universities as follows:

College	Total No. Degrees in 1912	Total in 1902	Total in 1911
Allegheny	63	35	64
Amherst	95	97	96
Bates	91	57	92
Bowdoin	98	55	85
Brown	210	187	193
Bryn Mawr	77	68	70
Carnegie Tech	242	..	189
Clark	58	..	35
Colby	69	38	38
Colgate	72	37	48
Columbia	1,504	788	1,334
Grinnell	76	51	83
Hamilton	47	..	30
Harvard	1,000	1,033	1,003
Indiana University	372	124	347
Lehigh	85	45	95
M. A. C.	83	22	43
Middlebury	55	19	55
M. I. T.	286	200	253
Mount Holyoke	167	101	134
New York University	583	339	545
Northwestern	591	506	574
Ohio State	501	141	422
Penn State	266	28	247
Princeton	327	291	268
Radcliffe	117	100	84
Rensselaer	118	21	71
Rutgers	75	72	73
Simmons	95	..	73
Smith	372	229	360
Swarthmore	63	52	68
Syracuse University	480	207	417
Trinity	36	29	36
Tufts	238	137	214
Union	60	38	49
University of Cincinnati	191	121	158
University of Illinois	858	511	798
University of Maine	109	67	133
University of Michigan	1,143	858	1,093
University of Missouri	432	153	383
University of Pennsylvania	828	521	850
University of Pittsburgh	284	170	260
University of Vermont	96	80	109
Wellesley	299	155	289
Williams	93	67	97
Worcester Polytechnic	77	44	77
Yale	855	583	904

THE HARPSWELL LABORATORY

THE following persons have carried on investigations during the summer of 1912 at the Harpswell Laboratory:

Franklin D. Barker, associate professor of zoology in the University of Nebraska.

George A. Bates, professor of histology, Tufts College Medical School.

Henry B. Bigelow, assistant in the Museum of Comparative Zoology, Harvard University.

Margaret H. Cook, instructor in zoology, Wellesley College.

Ulric Dahlgren, professor of biology, Princeton University.

Charles H. Danforth, instructor in anatomy, Washington University.

Vincent Gregg, preparator in histology, Princeton University.

Robert W. Hall, professor of biology, Lehigh University.

Duncan S. Johnson, professor of botany, Johns Hopkins University.

W. O. Redman King, demonstrator in zoology, University of Leeds, England.

J. S. Kingsley, professor of zoology, Tufts College.

F. D. Lambert, associate professor of biology, Tufts College.

H. V. Neal, professor of biology, Knox College.

H. D. Senior, professor of anatomy, University and Bellevue Medical College.

L. E. Thacher, student, Tufts College.

Caroline B. Thompson, associate professor of zoology, Wellesley College.

Hardolph Wasteneys, assistant, Rockefeller Institute for Medical Research.

SCIENTIFIC NOTES AND NEWS

Sir W. H. White has been elected president of the British Association for the Advancement of Science for the meeting to be held next year in Birmingham.

Fordham University has conferred the honorary degree of LL.D. on Drs. Henry Head, of London, Carl Jung, of Zurich, Nicolas Achucarro, of Madrid, and H. R. Storer, of Newport, R. I.

On Thursday afternoon, September 12, 1912, at the Brooklyn Botanic Garden, a sweet gum tree (*Liquidambar Styraciflua*) was planted in the local flora section of the garden, by Professor Hugo de Vries, of Amsterdam. About one hundred invited guests were present at the exercises. A dinner was given in Professor de Vries's honor at 6 o'clock, and in the evening he delivered a lecture, under the joint auspices of the garden and the department of botany of the Brooklyn Institute of Arts and Sciences, on "Plant Breeding in the Botanic Garden of Amsterdam."

Dr. George Santayana, professor of philosophy at Harvard University, has resigned.

Mr. A. Wendell Jackson, who has arranged a loan of $50,000,000 to China, in opposition to the offers of the financiers of the six great powers, is a mining engineer who was formerly professor of mineralogy and economic geology at the University of California. He is a fellow of the American Association for the Advancement of Science and a fellow of the Geological Society of America.

Dr. Jean Mascart, of the Observatory at Paris, has been appointed director of the Observatory at Lyons, as successor to M. André.

Dean Milo S. Ketchum, of the College of Engineering of the University of Colorado, was recently elected president of the Colorado Association of Members of the American Society of Civil Engineers.

At the meeting of the Missouri Section of the American Chemical Society, held Friday evening, July 26, in the chemistry lecture room, University of Missouri, Mr. N. W. Arthur, research chemist of the General Electric Co., Schenectady, N. Y., spoke on a new electric furnace and new electric furnace products as SiO-monax and monas.

Dr. W. J. G. Land, of the botanical staff of the University of Chicago, sailed from San Francisco on August 27, for a trip of four months in the Hawaiian, Samoan, Fiji and Tongo Islands, with probably an extension through the New Hebrides to Australia. The chief purpose of the trip is to investigate the bryophytic flora and to secure critical material of it for morphological study. Incidentally, research material in other groups also will be secured.

Mr. and Mrs. C. William Beebe have returned from a three months' trip to Europe in the course of which the pheasants in the

museums of London, Tring, Paris and Berlin were studied. The large series thus passed in review provided data for many generalizations hitherto impossible. A summary of the results will soon be published, the details of the work being reserved for the monograph on which Mr. Beebe is engaged, to be published under the auspices of the New York Zoological Society.

DR. F. R. WATSON, of the department of physics of the University of Illinois, has returned after a year's leave of absence. The year was spent almost entirely in Germany, where the universities of Berlin and Munich were attended, and special work was done in the subject of acoustics.

PROFESSOR WILLISTON S. HOUGH, dean of the Teachers College and professor of philosophy at the George Washington University, Washington, D. C., died suddenly on September 18 at the age of fifty-two years.

DR. JOHN WADE, reader in chemistry in the University of London, known for his work in organic chemistry, was killed by a bicycling accident on August 15, aged forty-eight years.

M. LOUIS CRIE, professor of botany at Caen, has died, aged sixty-two years.

THE death is announced of Dr. Rudolf Hörnes, professor of geology at Graz, and distinguished for his work on earthquakes.

PROFESSOR HERMAN F. WIEBE, of the State Institute of Physics and Technology at Hamburg, died at the age of sixty years in New York City, where he had come to attend the International Congress for Testing Materials.

THE International Congress of Mathematicians recently meeting at Cambridge adjourned to meet in Stockholm in 1916.

THE fourteenth meeting of the Australasian Association for the Advancement of Science will be held in Melbourne in January, 1913.

THE International Congress on Hygiene and Demography opened on September 21. President Taft, honorary president of the congress, opened its session at 11 o'clock on that morning. The delegates number some 2,800, representing thirty-three foreign governments, every American state and territory, over 300 American cities, leading colleges and universities here and in Europe, and many scientific, medical and social institutions throughout the world. In addition, many eminent visitors are in attendance. The congress is divided into eleven sections and four general sessions have been arranged. Dr. Henry P. Walcott, chairman of the State Board of Health of Massachusetts, is president of the congress. The presidents of the sections are as follows:

Professor Theobald Smith, Harvard Medical School, Boston, Hygienic Microbiology.

Dr. Russell H. Chittenden, professor of physiology and chemistry and director of the Sheffield Scientific School of Yale, Dietetic Hygiene.

Dr. A. Jacobi, New York City, president of the American Medical Association, The Hygiene of Infancy.

Dr. Lewellys F. Barker, professor of internal medicine of Johns Hopkins University, Mental Hygiene.

Dr. George M. Kober, professor of hygiene at Georgetown University, The Hygiene of Occupations.

Dr. Hermann M. Biggs, medical director of the department of health, New York City, The Control of Infectious Diseases.

Dr. Frank F. Wesbrook, professor of pathology and bacteriology of the University of Minnesota, State and Municipal Hygiene.

Dr. Prince A. Morrow, New York City, Sex Hygiene.

Dr. Rupert Blue, Surgeon General of the United States Public Health Service, The Hygiene of Traffic and Transportation.

Dr. Henry G. Beyer, U. S. N., Military, Naval, Tropical and Colonial Hygiene.

Professor Walter F. Willcox, president of the American Statistical Association, Cornell University, Demography.

DR. W. S. BRUCE, the Scottish explorer, has arrived at his home near Edinburgh, from his surveying expedition with Dr. R. N. R. Brown in Spitzbergen. According to the London *Times* the explorers have made a detailed topographical survey of the region traversed by them and a general geological investigation. They traveled from Bjona Haven to Advent Bay by a new route over land in which, so far as is known, reindeer,

ptarmigan and other game used to abound. In the whole journey of nearly 60 miles, however, not a ptarmigan, fox or reindeer, except skeletons and rotting carcasses, was seen. Dr. Bruce strongly condemns the wholesale extermination of animal life carried out in Spitzbergen, not only by gun and trap but by poison. Norwegian hunters, he says, habitually put down poisoned bait for bears, foxes and other animals, and he holds that strict measures should be taken to protect the fauna of Spitzbergen, which at present is being rapidly and ruthlessly destroyed. A great development of the coal mines, chiefly under the auspices of American capital and enterprise, and of other mining activities financed by British capital, was observed. There is activity also on the part of the Norwegians, who are developing means of communication by post and wireless telegraphy.

The Colorado Geological Survey has had three parties in the field during the summer of 1912. One party, under the direction of Assistant Professor Ralph D. Crawford and Mr. Philip G. Worcester, has continued the work begun last season in the Goldbrick district. A second party, under the direction of Professor H. B. Patton, of the Colorado School of Mines, has spent the summer in the Bonanza Mining district near Villa Grove. A third party, directed by Dr. George I. Finlay, of Colorado College, has been at work on an investigation of the water resources of the Arkansas Valley region.

Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, has been given leave of absence by the university trustees during the autumn quarter of 1912 and the winter quarter of 1913, to act as the Barrows lecturer in India. The Barrows lectures are given every three years in the principal cities of India, on the foundation established by Mrs. Caroline E. Haskell. The general purpose of the lectureship is to consider the relation of Christianity to other religions. Professor Henderson will lecture in some of the cities of Japan and China on his return to this country. His predecessor on the Barrows Foundation was Charles Cuthbert Hall, former president of Union Theological Seminary, New York. Professor Henderson's lectures in India will be issued in book form by the University of Chicago Press.

UNIVERSITY AND EDUCATIONAL NEWS

At the September meeting of the Yale Corporation it was announced that since the last meeting three wills have been filed for probate from which the university should receive during the year about $750,000. These include $250,000, unrestricted, by bequest of Matthew C. D. Borden, Yale, 1864; $25,000 from Cyprian Brainerd, of the class of 1850, for the use of the medical department, with ultimately an additional $40,000 after the death of certain beneficiaries, and the McPherson fund of between $400,000 and $500,000, "to be employed in assisting worthy indigent students." This bequest is due to the death of Aaron S. Baldwin, executor of the will of the widow of Senator McPherson, of New Jersey. Mrs. McPherson's will provided for this bequest. Announcement was also made that $10,000 had been received from the Misses Kingsbury as a history publication fund in memory of the late Frederick John Kingsbury, of Waterbury, for many years a member of the Yale Corporation; also $5,000 from Mrs. Arthur Ryerson, widow of the late Arthur Ryerson, Yale, 1871, to establish the Arthur Larned Ryerson scholarship in Yale College in memory of her son; also $3,000 from Francis D. Hurtt, 1907, Law School, to establish the Sarah Ives Hurtt scholarship in the Law School.

Professor William D. Harkins has removed from the University of Montana to the University of Chicago, where he will have charge of the research work in general chemistry, and will give courses in inorganic and general chemistry. His position as professor of chemistry in the University of Montana has been given to Dr. R. H. Jesse, instructor in chemistry in the University of Illinois. Mr. W. G. Bateman, former professor of chemistry in the Imperial Chinese University,

has been appointed instructor in chemistry in the University of Montana, in place of Mr. J. W. Hill, who has resigned.

DR. MADISON BENTLEY, assistant professor of psychology in Cornell University, has been called to the chair of psychology in the University of Illinois. Dr. H. P. Weld, of Clark University, becomes assistant professor of psychology at Cornell.

DR. W. F. BOOK, of the University of Montana, has accepted an appointment as professor of education in the University of Indiana.

THE department of physics of the University of Illinois has added two new assistants to its teaching staff for the present year, Mr. W. H. Bair, for some time a teacher of science in the high schools of Illinois, and Mr. Earle H. Warner, assistant for several years in the department of physics of the University of Denver. Both men are to serve as half time assistants.

DR. ALVIN R. PEEBLES, formerly professor of the theory and practise of medicine in the University of Colorado, has been appointed head of the department of preventive and experimental medicine, which has been established by the regents.

DR. THOMAS CLACHAR BROWN, a graduate of Amherst, who received his doctorate from Columbia in 1909 and who has since filled the positions of assistant professor of geology at Middlebury College and assistant professor of geology at the School of Mines, Pennsylvania State College, has been appointed associate in geology at Bryn Mawr College.

MISS MARY D. MACKENZIE, professor of biology at Western College, Oxford, Ohio, has been appointed head of the biology department of the Margaret Morrison School for Women of the Carnegie Institute, Pittsburgh.

PROFESSOR J. LORRAIN SMITH, F.R.S., professor of pathology and pathological anatomy in the University of Manchester, has been appointed to the chair of pathology in the University of Edinburgh, in succession to Professor W. S. Greenfield.

DR. J. STILLE, of the Technical Institute at Hanover, has been appointed professor of geology and paleontology at the University of Leipzig.

DISCUSSION AND CORRESPONDENCE

THE POLICY OF THE GEOLOGICAL SURVEY

TO THE EDITOR OF SCIENCE: In his paper on "A National University," printed in the issue of SCIENCE of August 16, President Van Hise takes occasion to comment on the neglect of science by the scientific bureaus. He states that the United States Geological Survey "is almost exclusively a department of practical geology" and "is not contributing in any large way to the advancement of science."

President Van Hise seems to be comparing the Geological Survey in the first decade or so following its organization with the larger service of to-day. As I am in part responsible for the Survey's present policy, I may perhaps be permitted to present this matter in its other phases. The question whether his statement is justified is not easily debatable, for the premises on which any argument should rest are not of a kind readily agreed upon. In fact, President Van Hise and other geologists might disagree as to what constitutes "advancement of science," and as to what is "practical geology." This unavoidable confusion of definition prevents any adequate comparison of past and present contributions or even of an earlier and the present personnel.

With this inherent difficulty in discussing generalities, it becomes especially a matter of regret that President Van Hise contented himself with reiteration of the charge, without definition of his terms or mention of any supporting facts. The question therefore resolves itself into a consideration of the degree of truth or justice in President Van Hise's two dicta: the Survey is "almost exclusively a department of practical geology," and "it is not contributing in any large way to the advancement of science." These deserve to be considered separately, because I can not admit that the one is a corollary of the other.

Geologic research as conducted under government auspices should, in my opinion, be largely practical. The purposes for which the United States Geological Survey was organized, both as specified by Congress and as recommended by a committee of the National Academy of Sciences, are practical, and the administrator who would venture to disregard the plain intent of that legislation would not contribute to the ultimate advancement of science. The Survey began on very practical lines, Director King arranging the initial work in districts offering "examples of instructive geological structure and great bullion yield," and even that classic work of science planned as the first monograph of the new survey, "Lake Bonneville," had its practical side, the hope having been expressed by Mr. Gilbert himself in a report of progress "that a critical investigation of the secular oscillations of climate in the past will help to solve the problem of secular change which is of such vital importance to the agriculture of an arid domain."

The most recent index of the trend of the Survey's work is afforded by the schedule of manuscripts being edited August 15, which affords some basis for judging of the character of the publications now in hand. The publications issued each year are known to the public, although I might mention as noteworthy in this connection two contributions that are just coming from the press: Monograph LI., "Cambrian Brachiopoda," by Walcott, and Professional Paper 71, "Index to North American Stratigraphy," by Willis. Of the 41 reports now being edited 5 are engineering bulletins, embodying data incidentally collected in the course of topographic surveys, and therefore not chargeable to scientific appropriations; 8 relate to Alaska and represent work done under an appropriation made specifically "for the investigation of mineral resources" and therefore not to any large extent available for theoretical investigations, though the results of the work in Alaska are a splendid contribution to our knowledge of the geology of the globe; 8 are water-supply papers contributed from the work under another specific appropriation; 6 relate to economic geology; and the remainder, 14, may fairly be described as outside the "department of practical geology." This group of 14 includes 6 paleontologic reports, 3 descriptions of areas having no special economic importance, and one report under each of the following subjects —glaciers, Pleistocene geology, petrography, stratigraphy and mineralogy.

That the United States Geological Survey concerns itself with the practical side is true now as it has always been in the past; whether its work is more or less devoted to practical geology than formerly can be decided according to one's taste or prejudices; but that it is almost exclusively a department of practical geology must be denied.

Besides making general investigations in geology and highly specialized researches in paleontology, petrography, mineralogy, geophysics and geochemistry, which it will be generally agreed contribute to the advancement of science, the Survey is making other investigations whose theoretic results are so closely combined with the results of practical geology that their scientific value may be overlooked by some readers. In some cases the "purely scientific" conclusions reached are incidental to the practical investigation, but in many instances are essential to it. To-day, as in the past, the study of ore deposits by the Geological Survey continues to yield a large measure of scientific results of the highest grade, and the five manuscripts on economic geology mentioned above are no exception to this rule. Most of these are not detailed descriptions of mining camps, but deal to a great extent with the areal geology and physiography of the hitherto blank spaces on the geologic map of the United States. The broader studies are not neglected—a fact illustrated by a manuscript just received from Professor W. H. Emmons on "Secondary Sulphide Enrichment," which represents results gained in the course of economic work in several mining districts during the past twelve years. That the answers to the problems of chemistry and physics here discussed possess a practical present value to the mining engineer

in nowise detracts from their permanent value to the broad science of geology.

An example of work on a broad problem that concerns a number of states is afforded by the general and detailed study of the Atlantic and Gulf Coastal Plain which for five years has been prosecuted under the direction of T. W. Vaughan with the cooperation of several state and federal geologists. Similarly, the mapping of the San Juan region by Whitman Cross serves as a notable example of a general investigation of broad scientific interest, covering two decades. A third illustration is to be found in the geologic work of Messrs. Campbell and Alden in the new Glacier National Park. It is conceivable that the publications resulting from such geologic investigations will stand as large contributions to science, and when this literature has been illumined by the added glamor of the years, the Geological Survey of to-day may be cited as again "the center of the world for the advancement of the science of geology."

More than this, the application of geology to economic problems has a reflex effect upon the science. The association of the scientist with the engineer is beneficial to both. The geology that is applied to big problems, whether of engineering or of governmental policy, must be not only qualitatively true, but also quantitatively exact. So the entrance of the Geological Survey into the administration of the public lands has modified field methods and established standards of accuracy not before demanded. The result is that the geologist who works in terms of forty-acre tracts observes details that were overlooked by his predecessor who looked the country over by the square mile.

The recognition of the applicability of geologic data collected by government scientists to the administration of the public lands is in itself, I believe, a large contribution to the advancement of science. The field of science is broadened and the standing of science is dignified. The remark of the geologist whose experience had been gained largely in the east but who is now working in a western mining camp illustrates this: "It is a satisfaction to be looked upon as a worker and not have to make apologetic explanations as to what geology means."

Another illustration is afforded in the work of the Geological Survey in connection with the proposed forest reservations in the east. For years the geologists and hydrographers of the Survey had taken interest in the question of the relation of forest cover to stream flow and as opportunity afforded had made observations bearing on the question. The results, however, were at best only qualitative and to some extent confusing. The Weeks Act, however, specifically laid upon the Survey the burden of making an affirmative showing of the regulative effect of the forest upon stream flow, before land could be purchased, and then an investigation was planned with the purpose of obtaining conclusive results. That the Survey withstood popular clamor until its investigation was concluded and reported only on observed facts may of itself have been a possible aid in advancing science. As an intensive study, the hydrometric survey of selected areas in the White Mountains is believed to be without parallel in the world, and it has yielded quantitative results which, when thoroughly digested and compiled, will be published as an important contribution to science. This opportunity to apply science to an administrative problem came to the Geological Survey because its work was believed to be both practical and scientific; and I may add my opinion that whenever this bureau becomes exclusively "practical" or exclusively "scientific" it will cease to deserve either recognition or support. This idea has been best expressed by Brooks: "Applied geology can maintain its present high position of usefulness only by continuing the researches which advance the knowledge of basic principles."

GEO. OTIS SMITH

SCHOOL GRADES—TO WHAT TYPE OF DISTRIBUTION SHALL THEY CONFORM?

THOSE administrators who have given the subject of scholarship marks or school grades considerable attention, will appreciate President Wm. T. Foster's article, "The Scientific

Distribution of Grades at Reed College," which appeared in the June 7, 1912, issue of SCIENCE.

Without wishing to criticize the Reed College system which the writer considers amply adequate to bring about uniformity in grading at Reed College itself, there yet remains the question, is the Reed College system the one most likely to be adopted by other educational institutions? The extent to which the question of grading is at present agitated justifies the conclusion that there is a tendency toward the standardization of grades—not only within the walls of a given school, but among the schools themselves. As long as no absolute units for mental measurement exist, the one essential factor for standardized grades is that the *form* of the distribution of these grades be identical for the various institutions. If this is true, the question arises what form of distribution shall be adopted?

The form adopted by Reed College is a modification of the normal curve, *skewed* to take account of the "selected nature of college students." It is this question—the advisability of skewing the normal curve—which is to be considered in this paper.

From present indications, if the various educational institutions throughout the country were suddenly obliged to adopt a uniform type of distribution for their grades, it is probable that the normal type of distribution is the one which would be most readily accepted. As soon as deviations, either in one direction or the other, are suggested, each faculty would insist on skewing the curve in the direction which would best express, in the opinion of the faculty, the local conditions. If the different school faculties are encouraged to express in their grades the degree of selection which they believe to exist in their student body, the personal element will again become so strong as to eliminate the uniformity which a scientific system is supposed to introduce. In a faculty composed mainly of "home talent" there is a tendency to suppose that its particular students are a specially selected group with respect to intelligence, and under such conditions it may happen that a faculty will adopt a form of distribution in which *all* of the students are supposed to be above the general average instead of only three fourths, as is done in the Reed College curve.

Until a system of absolute mental units has been invented, it is futile to try to make grades represent absolute accomplishment. The best that can be done under the conditions is to let the grades express *relative* accomplishment. It should be clear that skewing the normal curve is an attempt to make grades represent absolute accomplishment in that the degree of deviation from the normal type of distribution is supposed to measure the degree of superiority or inferiority, above or below some hypothetical absolute accomplishment of the population at large. Since we do not know enough about the intellectual capacity of the population at large to gain general acceptance for such numerical values as we might choose to assign, perhaps it would be better, for the present, to be satisfied with measuring relative accomplishment. To justify the deviation from the normal curve shown by the Reed College system, it seems that the following two factors should permit of quantitative statement.

1. The *numerical degree* of the selection with respect to *scholarship*.

2. The difference in the *form* of the distribution of the selected group, from that of the unselected group.

With respect to (1) it is doubtful whether the data at our disposal are of such convincing validity as to justify our giving it numerical values, especially when we consider not only those students who fail to attend the university after finishing their high-school work, but also those who drop out during the first, second and third high-school years. Many students leave high school because their parents have not the means to enable them to continue; some students get dissatisfied with the school work and prevail upon their parents to let them go out and do "real work." It is not necessary here to indicate the many reasons for which children leave the high

school—reasons which have nothing to do with the intellectual ability of the student. The percentage of successful men and women who have never completed a high school course is still too large to warrant the conclusion that the elimination which takes place can be accurately expressed in terms of scholarship. That some selection with respect to scholarship takes place may very well be admitted but at present we are not in a position to isolate this from the numerous other factors which make college enrollment less than that of the high schools.

Further, to assume that 75 per cent. of its students are above the general average, as is done in the Reed College system, is a verdict which should come from some other source than Reed College. If it is found, for instance, that Reed College graduates invariably do better work than the graduate students from other schools, it would be possible to calculate the superiority of Reed College students. This is the only sense in which the term selection would have any significance. It is the product, not the raw material, which should characterize a school.

Reed College could also calculate the relative standing of the high schools from which it draws its students. This would be a comparatively simple task if all the high schools graded their students in strict compliance with the normal curve, but if the several schools adopted curves which deviated from the normal, each school deviating to the extent which most appealed to it, an attempt at fixing a definite value for a particular grade would be almost as hopeless a task as it is now.

If, however, all educational institutions awarded grades strictly in compliance with the normal curve, these grades would at least express the same *relative* scholarship. If then the graduate schools found that the students from one institution did better work than students having the same grade from other institutions, the graduate schools could easily calculate a selection coefficient which would express the degree of selection for the different schools. Of course, this can not be done at the present time, but the writer merely wishes to point out that the factor of selection can not be scientifically evaluated with the data now at our disposal. To encourage a faculty to express this ambiguity in its grades is only transferring the grading idiosyncrasies from the individual instructor to the faculty.

With respect to (2), it is questionable whether the selection of scholarship which exists is of such a nature as to change the *form* of the distribution in a measurable degree. It is of course to be understood that the average accomplishment of a poor class may be less than the average accomplishment of a better class, but it does not follow that the grades are distributed differently on either side of the respective class averages.

An elementary class in experimental psychology of about 150 students at the University of Missouri were graded for a whole semester according to the average accomplishment of the whole class. The Ebbinghaus conjectural method of examination was used so that the personal equation of the instructor might be eliminated as much as possible, and also to approach more closely to the absolute accomplishment of the students.[1] The correlation between the actual grades and those expected from a normal type of distribution was then calculated according to the following scheme.

Number of Examinations	Extent of Correlation with Normal
1	.730
2	.970
9	.996

We have here a gradual approach toward the normal type of distribution. If only a single examination is given the distribution may be decidedly skewed. This does not, however, show conclusively that the scholarship is not normally distributed. If the examination does not fairly test the scholarship of the

[1] A more detailed report of this investigation is to be found in *The Journal of Experimental Pedagogy and Training College Record* (Sheffield), Vol. 1, No. 4, June, 1912.

class, if it is too easy or too difficult, a skewed distribution may result even if the scholarship of the class is actually normally distributed. In the above investigation, as the number of examinations increased there was a closer approach toward the normal type of distribution and when nine tests had been given the actual distribution was practically identical with that of the normal type. This was also true for the elementary classes in chemistry. In general it is the writer's experience that as the methods of examination are refined and as the number of students and the number of tests is increased there is a closer and closer approach toward the normal curve. Mathematically speaking, the normal curve seems to be the limit which, with refinement of method and the elimination of accidental variations, tests of general intelligence approach. It is to be remembered that these students were university freshmen and sophomores upon whom the effects of high school selection have been operative. It is possible that if all the high-school classmates of these students had continued and taken the same course in the university the average accomplishment of the whole class might have been somewhat less, yet it is not likely that the *distribution* would have been different.

That some mental tests are not normally distributed need be no cause for criticism when we recall that the essential factor in grading is *uniformity*. What a particular grade will eventually signify will depend upon how successfully or unsuccessfully the students who are characterized by this grade meet the demands of higher institutions or the demands of the world at large. It will not depend upon whether the grade is found below or above some hypothetical accomplishment of the population at large.

There is another question which might be asked, namely: How many of the ten grades awarded by Reed College represent distinguishable degrees of scholarship? At the University of Missouri only five different grades are awarded, and from working with the records of these students the writer is inclined to believe that students who are only a little above or below the average in some courses tend to approach closer to the average when the grades in their other courses are taken into account. If this is a fact then it is possible that the Reed College grades 5, 6, 7, do not represent different degrees of scholarship. There is no way of determining this at the University of Missouri, but Reed College has the data for making this investigation. If three series were to be formed as follows:

Series I.—Students whose grades are between and including the limits 4–6. (Those students who have no grade higher than 4 nor a grade lower than 6.)

Series II.—The same for the grade limits 5–7.

Series III.—The same for the grade limits 6–8.

If after credit units are considered the averages of these three series are not respectively 5, 6, 7, but approach more closely to each other, say 5½, 6.0, 6½, this would show that the grades 5, 6, 7, do not represent distinguishable degrees of scholarship. It would, no doubt, be of considerable interest to school administrators to have a report from Reed College on this point.

In conclusion we may summarize the arguments in this paper as follows:

Such mental tests as are significant for determining school grades approach the form of the distribution of the normal curve. The deviations from the normal curve may be considerable, but some of the deviation is due to factors other than those of scholarship. Where the deviation is due to a number of interrelated causes it is difficult to assign a value to the effect of a single one of them. In the interest of uniformity in grading it is essential that the *form* according to which the grades are distributed be *the same for the different schools.* Since the normal curve is a purely theoretical invention closely approximating the actual conditions and is at the same time not hampered by empirical considerations, its mathematical simplicity and

the relatively extensive knowledge which we have of its properties, seem to commend it as the most useful curve to represent the type of distribution to which scholarship marks should conform. If it is desirable to have the grades express significant local factors, this can always be done by adding some constant value to these grades, and the constants so found will also give an index as to the scholarship of a particular institution.

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SCIENTIFIC BOOKS

Nature's Harmonic Unity. By SAMUEL COLMAN, N.A. Edited by C. ARTHUR COAN, LL.B. New York, G. P. Putnam's Sons. 1912. Cloth, $8 \times 9\frac{1}{2}$ in. Pp. viii + 327; 302 illustrations. $3.50 net.

The purpose of this book appeals to the scientist and ought to be a matter of serious study for every beginner in the vocation of arts.

It contends to prove that pleasing forms of nature, as well as of human creation, are ruled by mathematical laws.

That this is true to a certain extent has been shown by the reviewer in an article on "Mathematical Principles of Esthetic Forms," which in October, 1900, appeared in the *Monist,* and in various other publications, where also a number of important references may be found. The fact that the author does not seem to be familiar with these accounts for some serious defects in the presentation of the subject. A writer who attempts to explain the principles of esthetic forms in nature should not neglect to study, for example, Schwender's "Vorlesungen über Mechanische Probleme der Botanik."[2] Furthermore, what a rich source of beautiful natural forms might he find in Haeckel's "Kunstformen der Natur."[3]

In neglecting the physiological and psychological factors of the problem, the treatment must necessarily become antiquated and, from the standpoint of the exact scientist, in many parts shrouded by a semi-mathematical mythology and naïvely stated principles.

The book contains, nevertheless, a number of very readable chapters which will be of value to any one interested in the problem. The examples chosen from biology are by far the most interesting, while some of those in architecture are of questionable value. See, for instance, on page 79, the combined figure of a snow crystal and the Parthenon. It is evident that a hexagonal figure may always be drawn to fit the tinted square and resembling a snow crystal. But what about the exact dimensions? Again, the paraphrase of a vase, p. 273, designed according to, what in this and similar cases I call mathematical mythology, is certainly no object of universal admiration. Notice the painfully weak points in the foot.

The Greeks did not know the logarithmic spiral as would appear from a statement in connection with the discussion of the Ionic volute in the chapter on conchology. This particular spiral, expressed by the polar equation $\rho = e^{a\theta}$, was discovered by Descartes in 1638. When writing about the Ionic order, why not mention the Lituus ($\rho^2 = a^2/\theta$) discovered by Cotes in 1722. It seems strange too, that the catenary should be given the prize as the most beautiful curve. Those algebraic lines which pass through the circular points are generally considered as the beauties among the curves.

The technical aspect of the book is generally pleasing. It is, however, to be regretted that in a treatise with esthetic purposes most of the geometric figures should be so crudely drawn. They are clumsy-looking and lack neatness and precision of execution.

[1] "Mathematik in Natur und Kunst," *Mitteilungen der Naturforschenden Gesellschaft in Solothurn,* Vol. XV., 1906. "Sur quelques exemples mathématiques dans les sciences naturelles," *L'Enseignement Mathématique,* Vol. XII., Paris, 1910. "Wiskunde en Natuurlijke Historie," *Wiskundig Tijdschrift,* Vol. 10, Haarlem, 1910. "Mathematics and Engineering in Nature," *Popular Science Monthly,* November, 1911.

[2] Engelmann, Leipzig, 1909.

[3] Leipzig, 1899–1903.

We fully agree with the author when he states:

> Proportion is a principle in nature which is a purely mathematical one and to be rightly interpreted by man through the means of geometry; therefore geometry (?) (mathematics) is not only the gateway to science but is also a noble portal opening wide into the realms of art. Still to a great majority of artists, and to the world at large, the effort to relate science with art is now looked upon with the greatest disfavor and even repugnance, and this accounts in a measure for the overwhelming percentage of immature work which characterizes all branches of art in our times.

It would be another extreme, however, to try to explain all natural forms and everything in art by stereotype mathematical laws. This would soon lead to barren formalism and sterility. True art in many of its phases must conform with mathematical, or, more generally, scientific principles. But it can not live without the inspiration derived from physiological and psychological factors.

Colman's book on "Nature's Harmonic Unity" serves a very noble purpose: a rational appreciation of beautiful natural forms and, based upon it, the cultivation of a truly artistic spirit.

It is for this reason that, in spite of its defects, we wish a large circle of readers for it.

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A Revision of the Amphibia and Pisces of the Permian of North America. By E. C. Case. Washington, Carnegie Institution, Publication No. 146. 1911. Pp. 179, text figs. 56, plates 32.

This monograph is the third of a series by Dr. Case on the Permian vertebrates of North America. The work is divided into five parts: an historical review, a systematic revision, and a morphological revision of the Amphibia, a description of some Permian insects by Dr. E. H. Sellards, and a review of the Permian fishes of North America by Dr. Louis Hussakof. The historical review shows the development of the taxonomy and nomenclature of the Permian vertebrates from the earliest descriptions by Cope in 1875 to the time of publication.

In the systematic review the author has been very conservative and has rejected the more recently proposed classifications of the Amphibia. The one adopted is, in general, that most commonly in use for the Stegocephalia. Under this order two suborders are recognized, the Microsauria and the Temnospondyli. The author has used the term Microsauria (with question) in the sense commonly employed and has made no attempt to define this sadly mixed group. To it are referred the family Diplocaulidæ and genus *Diplocaulus*. The suborder Temnospondyli is divided into two groups, the rhachitomous and the embolomerous. Under the first division are placed 12 genera arranged in five families: family, Eryopidæ, genera, *Eryops, Parioxys, Anisodexis* (?), and *Acheloma;* family, Trimerorhachidæ; genera, *Trimerorhachis, Tersomius* and *Zatrachys;* family, Dissorhophidæ, genera, *Dissorhophus, Cacops* and *Alegeinosaurus;* family, Aspidosauridæ, genus, *Aspidosaurus;* family, Trematopsidæ (not Trematosauridæ), genus, *Trematops* (not *Trematosaurus*). The embolomerous division is represented by the family Cricotidæ and genera *Cricotillus* and *Cricotus*. Under the heading, "Incerte sedis," are placed, family, Crossotilidæ, genus, *Crossotelos;* family, Gymnarthridæ, genera, *Cardiocephalus* and *Gymnarthrus;* all referred to the suborder, Gymnarthria. Under the second order represented, the Urodela, is placed the family Lysorophidæ and genus *Lysorophus*. In this Dr. Case agrees with the majority in considering *Lysorophus* an amphibian in opposition to the few that still believe it a reptilian form. At the end of this section is a set of tables showing the characteristics of the various families, genera and species. These are so arranged that the related forms can readily be compared.

In the morphological revision the following genera are treated in detail: *Diplocaulus, Eryops, Acheloma, Trimerorhachis, Zatrachys, Dissorophus, Cacops, Gymnarthrus* and *Lysorophus,* genera which, till recently at least, were but little known. In an attempt to bring the publication up to date the author

has drawn freely from Williston, Broili and others in this part of the work.

The description of two new cockroaches by Dr. Sellards is of special interest, as these are the first insects to be described from the Permian of Texas.

In the discussion of the Permian fishes of North America, Dr. Hussakof points out that Cope, in a series of papers between 1875 and 1894, created several species without justification because of too fragmentary material or the failure to allow for individual variation. Through a restudy of Cope's types in the American Museum, the Gurley Collection at the University of Chicago, and with the addition of new material, Dr. Hussakof has added four new genera, which makes 14 in all. Curiously enough, however, because of subtractions and additions, the number of species is 22, the same as was given by Cope. In an appended table of comparisons some interesting things are brought out; it is pointed out that the Illinois fish fauna, with the exception of one group, the Petalodontidæ, is duplicated in the Texas fauna, a condition that indicates a close relation between the faunas of these two remote regions. A comparison of the Texas fauna with that of Bohemia shows a marked difference in the genera of the two localities, although, with one exception, the groups represented in each are the same. From this the author draws the conclusion that although the faunas must have arisen from a common stock, the two regions had long been separated before Permian times.

Through oversight, most likely, a few mistakes, of minor importance, perhaps, have been made to which attention should be called. The statement is made that *Ophiacodon mirus* Marsh and *O. grandis* Marsh, which Marsh considered reptiles, "are clearly amphibians of uncertain relationships." Williston has recently shown that *O. mirus* is a reptile and that *O. grandis* belongs with *Eryops.*

Pleuristion, which is evidently considered an amphibian and is placed under the Gymnarthria without comment, was treated by Dr. Case in his "Revision of the Pelycosauria" (p. 27). Here he is in doubt as to whether the genus is more closely allied to the Pelycosaurs or the Cotylosaurs. From evidence furnished by the humerus, as described and figured by Williston, as well as the vertebræ, *Pleuristion* is, in all probability, a cotylosaur and probably a member of the Captorhinidæ.

In the description of the humerus of *Diplocaulus* (p. 90) Dr. Case expresses the opinion that it may be reptilian. To quote:

"This [*Diplocaulus*] is the single case among the *Amphibia* of the Texas Red Beds, or their equivalent elsewhere, in which the entepicondylar foramen has been found in the humerus. The opening in the humerus of *Acheloma cumminsi* is purely accidental in the opinion of Williston, Broom and the author. For this reason it is possible that the humerus may be reptilian and in accidental association."

This hardly seems possible as these humeri are found associated with many specimens of *Diplocaulus* in the University of Chicago collection. And, furthermore, according to Broili, *Cochleosaurus,* an Upper Carboniferous Temnospondyl, has the entepicondylar foramen present in the humerus.

The present work will be of great interest to all paleontologists and of inestimable value to the student of Permian vertebrates. The compilation is so complete that it will no longer be necessary to turn to the original papers on these groups for the information desired. The text is illustrated with a great many new figures as well as copies after Broili, Williston and others. The plates, too, are worthy of special mention.

MAURICE G. MEHL

NOTES ON INFECTIOUS ABORTION IN CATTLE

IN recent numbers of SCIENCE Dr. Russell[1] and Dr. MacNeil have called attention to the fact that infectious abortion of cattle in this country is undoubtedly caused by the same organism as that found in Europe. It may

[1] Russell, H. L., SCIENCE, N. S., Vol. XXXIV., October 13, 1911, p. 494. MacNeil, W. J., SCIENCE, N. S., Vol., XXXIV., December 22, 1911, p. 874.

be of interest to very briefly review certain recent publications dealing with this disease. This is particularly true just at present, as it seems possible that this disease may have more than a passing interest for human medicine.

From the standpoint of the veterinarian the most important recent work is that from the laboratory of Dr. C. O. Jensen in Copenhagen, Denmark. This laboratory has devoted particular attention to the study of reliable methods of diagnosis. In September, 1909, Dr. Holth[2] published a preliminary report, on the use of agglutination and complement fixation for determining the presence of this disease.[3] During the past year Sven Wall, working under the direction of Drs. Jensen and Holth, has published[4] the account of extensive tests with these methods. Wall gives the details of the examination of eleven hundred (1,097) cows by the use of both methods. In many cases the cows were tested every month for from six to eight months. On the basis of this work Wall concludes that it is entirely possible by the combined use of these two methods to determine which cows are infected, or at least which ones have been infected within the last six or eight months. It should be noted here, however, that these serum tests offer no opportunity to distinguish between cows which have an active infection and those which have acquired a measure of immunity. Wall's work, however, indicates that the agglutinins and immune bodies gradually disappear. In from six months to a year after the infection, it is usually not possible to demonstrate the presence of these bodies.

The work of Holth and Wall has been corroborated by a number of recent investigations dealing with this disease. Professor Zwick, of the Veterinary Division of the Royal Health Bureau in Berlin, has contributed several recent papers.[5] He concludes that the methods of agglutination and complement fixation offer the proper means of diagnosis in this disease. Zwick also concludes that infectious abortion is much more widely spread among cattle than is usually believed. He further believes that infectious vaginitis is not a cause of abortion, but that the abortion in such cases is due to a separate infection with the Bang bacillus. Another paper dealing with the diagnosis of abortion is by Brüll[6] from the veterinary school in Wien. Brüll, using the agglutination method alone, found that the serum of cows which had aborted agglutinated the abortion bacilli in dilutions from 1 to 64 up to 1 to 16,000. The cows which had not aborted and came from farms where there had been no abortion never showed agglutination in dilutions higher than 1 to 64 and usually much lower. He concludes that this method may be used with success. All cows showing agglutination higher than 1 to 64 are believed to have been infected.

Still more recently MacFadyean and Stockman,[7] of the English Abortion Committee, have thoroughly tested the agglutination method. Of 535 steers, bulls and calves, which *a priori* were assumed to be non-infected, only nine showed agglutination in the dilution of 1 to 50, four in the dilution of 1 to 100 and only one in the dilution of 1

[2] Holth, Halfdan, "Die Agglutination und die Komplementbindungsmethode in der Diagnosis des Seuchenhaften Verwerfens der Kühe," *Berl. Tierärzt. Woch.*, Bd. 25, pp. 686–688, 1909.

[3] In the same year and independently, MacFaydean and Stockman, of the English Abortion Committee, also pointed out the possibility of using these methods.

[4] Wall, Sven, "Om Diagnosticering af infectoes Kastning hos Kvaeget ved Agglutination og Komplementbindung," *Maanedsskrift f. Dyrlaeger* XXI., 1910. Also "Ueber die Festellung des seuchenhaften Abortus beim Rinde durch Agglutination und Komplementbindung," *Zeit. f. Infektionskr. usw. der Haustiere*, Bd. 10, 1911.

[5] Zwick, *Central. f. Bakteriol. usw.*, Bd. 47, I. Abt. Ref. (Beilage), 1910; *Berl. Tierärzt. Woch.*, Bd. 27, No. 6, pp. 111–112, February, 1911; *Berl. Tierärzt. Woch.*, Bd. 27, No. 52, pp. 965–969, December, 1911.

[6] Brüll, Ziga, "Beitrag zur Diagnostik des infektiösen Abortus des Rindes," *Berl. Tierärzt. Woch.*, Bd. 27, pp. 721–727, 1911.

[7] MacFadyean, Sir John, and Stockman, Stewart, "The Agglutination Test in the Diagnosis of Bovine Contagious Abortion," *Jour. Comp. Path. and Therap.*, Vol. XXV., pp. 22–38, March, 1912.

to 200. On the other hand, of 127 cows which had either aborted or came from infected herds, 62 (nearly 50 per cent.) gave some agglutination, although only 38 agglutinated in the dilution of 1 to 100 or more. Wall pointed out from his results that the use of the agglutination method alone is likely to lead to some errors and to many cases of uncertainty. In the main, however, as the above two papers indicate, its results are satisfactory.

Three papers dealing with the diagnosis of the disease in this country have recently appeared. The first of these is by Larson,[8] in which he concludes that the complement fixation test offers a reliable and satisfactory method of diagnosis. Another paper which is a continuation of the work started by Larson is by Hadley and Beach,[9] in which again the complement fixation reaction is used alone. A third paper is by the writer[10] in which both the agglutination and complement fixation reactions were tested.

The results of these papers are in agreement with European investigations and indicate that a reliable method of diagnosis in this disease is now available.

The perfection of these methods of diagnosis undoubtedly marks the greatest step towards the eradication of this disease which has yet been made. By their use it is possible to separate the infected from the uninfected animals. By proper methods of isolation and disinfection much can then be done towards ridding a herd of the disease. This is especially true in herds where the infection has just started.

In spite of the fact that the cause of this disease was discovered by Bang as early as 1896, very little progress has been made towards the perfection of a cure or a preventative. The most important contribution to this side of the subject also comes from Jensen's Laboratory and is by Dr. Halfdan Holth.[11] In an excellent contribution Holth gives many valuable observations on the growth and biology of the abortion bacilli. Many experiments dealing with the theory of immunity are also reported. The matter of most immediate interest, however, is that dealing with the artificial production of immunity. Holth clearly demonstrates that it is entirely possible to produce agglutinins and antibodies in animals treated with either living or dead cultures and with serum. Injection of living culture produces the largest amount of immune bodies and these remain in the blood for a longer period of time than with other treatments. Injection of a killed culture is the next most efficient way while the effects of an immune serum appear to be slight and transitory.

Experiments with rats and mice show that injection of either a serum or a properly prepared vaccine will protect them against an otherwise deadly dose of the abortion bacilli.

Whether these results will be borne out by experiments on cows or not is still unsettled. Experiments are under way in Denmark and other places which will settle this matter before long.

In this connection should be mentioned the excellent review by Oluf Bang[12] of the work

[8] Larson, W. P., "The Complement Fixation Reaction in the Diagnosis of Contagious Abortion of Cattle," *Jour. Infect. Dis.*, Vol. 10, pp. 178–185, March, 1912.

[9] Hadley, F. B., and Beach, B. A., "The Diagnosis of Contagious Abortion in Cattle by Means of the Complement Fixation Test," Wisconsin Agric. Exper. Station, Research Bulletin No. 24, June, 1912.

[10] Surface, Frank M., "The Diagnosis of Infectious Abortion in Cattle," Ann. Rpt. Kentucky Agric. Exper. Station, 1912 (Bulletin 166), pp. 303–366, June, 1912.

[11] Holth, Halfdan, "Kastningsbacillens Biologi og Immunitetsforholdene ved Sygdommen," *Maanedsskrift for Dyrlaeger,* XXII., 1911. Also "Untersuchungen über die Biologie des Abortusbacillus und die Immunitätsverhältnisse des infektiösen Abortus der Rinder," *Zeit. f. Infektionskrankheiten usw. der Haustiere,* Bd. X., 1911, 94 pp.

[12] Bang, Oluf, "Schutzimpfung gegen den infektiösen Abortus," Klimmer u. Wolff-Eisner's "Handbuch der Serumtherapie und Serumdiagnostik in der Veterinärmedzin," Leipzig, 1911, pp. 202–223.

that has been done in the attempt to protect animals against infectious abortion. Many experiments are reviewed in this article which are not to be found in the general literature of abortion. Many of these are scattered through Danish veterinary journals and many others are here published for the first time. The results of the experiments given indicate that there is some hope of producing immunity by means of vaccines or serums. There is, however, need of many long continued and carefully planned experiments to prove this. The insidious nature of the disease makes it very difficult to obtain crucial evidence. The above cited paper is an excellent summary of the work so far done in this direction.

Not the least interesting phase of the study of infectious abortion is that which has recently appeared from the laboratory of Dr. Theobald Smith.[13] In these papers Smith and Fabyan have clearly demonstrated a fact which has been overlooked by previous students of this subject, viz., that the abortion bacillus is able to cause marked pathological lesions in guinea-pigs and other laboratory animals. Further, these lesions are by no means confined to the reproductive organs, but affect in particular, the spleen, liver, bones, lungs, lymph-nodes and kidneys. The lesions are not unlike those produced by tuberculosis. In a few cases death ensued after some weeks, in others the animals appeared to recover and maintain a general good health. No external symptoms, other than a slight loss in weight, were present in the majority of cases. In some instances paralysis of the hind quarters was noted. Occasional cases of blindness and the enlargement of the lymph nodes were other symptoms.

The interest in the disease is increased by the fact pointed out by Smith and later by the U. S. Department of Agriculture[14] that the abortion bacillus occurs in the milk of infected cows and that the injection of such milk into healthy guinea-pigs will produce lesions similar to those noted above. Further, it is possible to recover the abortion bacilli from animals inoculated with such milk.

The fact that a large portion of dairy milk contains the abortion bacilli and the further fact that in cattle the most common means of infection is through the alimentary canal make it at least suggestive that this organism may be an etiological factor in certain human infections.

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[13] Smith, Theobald, and Fabyan, Marshall, "Ueber die Pathogene Wirkung des Bacillus abortus Bang," *Central. f. Bakt. usw.*, I., Orig. Bd. 61, pp. 549–556, January, 1912. Fabyan, Marshall, "A Contribution to the Pathogenesis of *B. abortus* Bang," *Jour. Med. Research*, Vol. XXVI., pp. 441–489, July, 1912.

[14] Bureau of Animal Industry, U. S. Department of Agriculture, Circular No. 198, March, 1912.

SPECIAL ARTICLES

THE EFFECTS OF ALKALOIDS ON THE DEVELOPMENT OF FISH (FUNDULUS) EMBRYOS

In previous experiments it was found that a large number of neutral salts and many anesthetics, including alcohols, when applied to *Fundulus* embryos, in concentrations slightly below the fatal dose, produce abnormalities in the eyes. The most striking of these abnormalities is the presence of one median eye instead of the usual eyes, a condition known as cyclopia. In some embryos but one eye is present and is lateral, as in the normal fish, a defect designated as monophthalmia asymmetrica.

Considering the variety of the "poisons" used, one might suspect that the *Fundulus* embryo reacts to all poisons by developing defects in the eyes, provided the right concentration of the harmful substances is found. To determine this, it is not necessary to try an infinite number of concentrations of the reagent, since I found that the concentrations producing cyclopia were the highest concentrations in which the embryos could live. It is only necessary to determine the lethal dose, and then make a finely graduated series just below this limit. In this way I have tried out

members of an entirely different class of substances, namely, alkaloids.

Of the alkaloids so far tried theobromine is not sufficiently soluble in sea water to affect the embryos noticeably. The effects of caffeine and theine[1] are identical. Nicotine is four times more toxic, but when used in proper concentration produces similar results ($M/400$ nicotine $= M/100$ caffeine).

The effects of these alkaloids is cumulative, *i. e.*, the greater the length of time the embryos remain in a solution, the less the concentration of the latter needed to produce a certain effect.

In the majority of the experiments, the embryos at about the four-cell stage, were placed in sea-water solutions of the alkaloids and allowed to remain thirty-six hours, then transferred to sea water.

The very constant effects of these alkaloids[2] are the enlargement of pericardium, ear and brain vesicles and cœlom, together with the suppression of the circulation. The heart may or may not beat, and may or may not contain erythrocytes. Erythrocytes are seen in the embryo, but not on the yolk sac. They are often clumped in masses of various sizes along the non-functional blood vessels. Black pigment cells migrate over the lower side of the pericardium and red pigment cells over the heart in an abnormal manner.

Primary cyclopia is extremely rare. In fact, the only cases found were two in the nicotine solutions. However, there are cases of secondary "one-eyedness" due to degeneration of one of the eyes or fusion of the eyes.

Many of the alkaloid embryos sooner or later begin to degenerate. Since degeneration occurs in other classes of experiments with *Fundulus* embryos in which the circulation is suppressed, the lack of a circulation might be considered the cause of degeneration. However, I consider this improbable, since many embryos lacking a circulation show no signs of degeneration, unless the œdema of serous cavities be considered such. The degenerative effects of alkaloids may not appear until after the period when the circulation is normally established, even though the embryos were removed from the solutions before this period. But this does not prove that degeneration is due to lack of a circulation.

One eye may degenerate before the other, but usually the degeneration is symmetrical. The degenerating eye becomes irregular in outline and finally its boundary can not be distinguished. The retinal pigment is the only part of the eye substance that remains identifiable in living specimens. In one specimen the two pigment masses moved from their position in the head and formed an attachment to the venous end of the heart.

In the stronger solutions, the cells over the whole surface of the embryo become loosened at an early stage. A process of de-differentiation occurs, and there finally remains but an irregular patch of cells, among which only the pigment cells are distinctive. In this condition the embryo may live for many days.

Similar degeneration may occur as the effect of other poisons, but seems to be more common as an effect of alkaloids. On the other hand, cyclopia is rarer in alkaloid embryos than in those treated with certain other substances. Whereas in solutions of ethyl alcohol 100 per cent. of the embryos may show primary defects in the eyes; such occurred in only about one in a thousand of the nicotine embryos. Although thousands of eggs were placed in caffeine and theine, this number is too small to exclude the possibility that cyclopia might occur as frequently as in nicotine.

Much has been said for and against the idea of the specificity of the action of various substances on embryos. The data found in the literature indicate that more qualitative and quantitative observations are needed on this subject. Organisms are not simply chemical compounds. In studying the mechanism of the effects of chemicals, the *structure* of the organisms should be especially considered; and not only the morphological structure, but

[1] Considered identical chemically.

[2] And of a number of others used since this went to press.

the chemical and physical nature of the component parts.

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On the Relationship between the Bilateral Asymmetry of the Unilocular Fruit and the Weight of the Seed which it Produces

The problem of symmetry, radial and bilateral, is of such great interest that it can not be approached from too many angles. The purpose of the present note is to discuss on the basis of a rather extensive series of quantitative data the question: "Do bean pods with an 'odd' number of ovules produce lighter seeds than those with an even (2, 4, 6, etc.) number?" Here the "odd" or "even" character of the pod is to some extent an index of bilateral asymmetry. Pods with an odd number of ovules must have them unequally divided between the two carpellary margins which form the ventral suture, while those with an even number generally have them equally divided. Thus with respect to the distribution of ovules, pods with an odd number must be bilaterally asymmetrical; those with an even number are generally bilaterally symmetrical.

The results which led up to the present study were the discovery of an intra-individual selective elimination of ovaries with a larger number of "odd" locules in *Staphylea*[1] and the demonstration of a usually lower fertility and fecundity in "odd" pods of *Phaseolus*.[2]

[1] For literature, see: "The Selective Elimination of Organs," Science, N. S., XXXII., 519–528, 1910; "On the Selective Elimination occurring during the Development of the Fruit of *Staphylea*," *Biometrika*, VII., 452–504, 1910; "Further Observations on the Selective Elimination of Organs in *Staphylea*," *Zeitschrift f. Ind. Abst.- u. Vererbungsl.*, V., 273–288, 1911; "The Measurement of Natural Selection," *Pop. Sci. Mo.*, LXXVIII., 521–538, 1911.

[2] "On the Relationship between Bilateral Asymmetry and Fertility and Fecundity." In press in Roux's *Archiv f. Entwickelungsmechanik*.

Among the series of individually weighed bean seeds gathered for a study of the pure line problem are five in which the number of ovules in the pod from which the seed was taken is recorded. These series (designated by key letters) are:

L. Golden Wax. Grown at Lawrence, Kansas, 1906. 2,861 seeds.

LL. Golden Wax. Plants the offspring of the L series, grown at Lawrence, Kansas, 1907. 3,947 seeds.

GG. Burpee's Stringless. Grown at the Missouri Botanical Garden, 1907. 8,364 seeds.

H. Navy. Grown near Sharpsburg, Ohio, 1907. 5,778 seeds.

D. Navy. Another series, grown under very different conditions near Sharpsburg, Ohio, 1907. 2,362 seeds.

The material is, therefore, rather extensive and diversified. Two methods of analysis are possible. (*a*) The pods may be merely classified as "odd" and "even" and the mean weight of the seeds produced by each kind determined. (*b*) A regression equation can be fitted to the whole data and the weighted mean deviation of the empirical means from the theoretical means determined for either "odd" or "even" pods.

Let o = number of ovules per pod, w = weight of seed in units of .025 grams. Then correlations and regression straight line equations are:[3]

Series	Correlation	Regression Equation
L	$r = -.0401$	$w = 16.4645 - .1597\ o$
LL	$r = +.0586$	$w = 13.0281 + .2060\ o$
GG	$r = +.0109$	$w = 17.3881 + .0354\ o$
NH	$r = -.1410$	$w = 11.0961 - .2806\ o$
ND	$r = -.1227$	$w = 8.5554 - .2583\ o$

The correlations are in all cases low. Testing the influence of the "odd" (asymmetrical) character of the pod upon the weight of the seed by the weighted mean deviation (regarding signs) of the average weights of seeds produced by odd pods from the theoretical means calculated from these equations as well

[3] Data from which all the constants given here may be checked will be eventually published for another purpose.

as by the method of comparison of averages for all "odd" and "even" we find:

Series	Regression Line Test	Difference in Means
L	—.0137	—.0030
LL	—.0768	—.2506
GG	—.0164	—.0329
NH	—.0597	—.0338
ND	—.0777	—.1754
Unweighted averages	—.0489	—.0991

By both methods all the deviations are negative in sign, though of a low order of magnitude. Apparently, bean seeds produced in pods with an odd number of ovules are about .0025 gram lighter than those in pods with an even number. Asymmetrical pods are, therefore, physiologically less efficient than symmetrical. To be sure the relationship is a very delicate one; the individual series show considerable fluctuations. Many more observations are desirable, but the duplication of a series of over 23,000 individual weighings with records of the characteristics of the pods from which the seed was derived is not easily carried out. The findings are consistent throughout within the limits of error. They confirm from an entirely different angle conclusions drawn from studies of selective elimination and of fertility and fecundity. It seems worth while, therefore, to place on record the results for the available data.

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HEAT CONDUCTIVITY OF CRYSTALS

FOR several years one of the experiments in our course in physical crystallography has been a qualitative determination of the conductivity of heat in crystals by the Senarmont method described by Groth, "Physikalische Krystallographie," page 178. The Senarmont apparatus is used for these tests. It consists of a stage for supporting the crystal, so arranged that a spring presses it up against the contact point of the conductor. The latter is bent at right angles and may be heated at the other end by a flame. Results were quite unsatisfactory because when the point, resting on the paraffined surface of the crystal, became heated it radiated sufficient heat to melt the paraffine and the figure, which might have been obtained by heat conducted through the crystal, was destroyed. Since the heat was radiated equally in all directions a circle in the paraffine resulted. A modification of this method gives much better results.

A plate of the mineral, for example, gypsum, about 1–2 mm. thick is dipped in melted paraffine until a thin even coat is formed on one side. The plate is then placed on the stage of the instrument with the paraffined surface down, but is insulated from the stage by strips of asbestos under the edges. The point of the conducting wire rests in a depression in the upper unparaffined surface. In this way, when the heat is conducted along the wire to the crystal it must actually be transmitted through the gypsum before it can melt the paraffine. A very sharply defined ellipse will be noted in the paraffine and this is clearly due to differences in conductivity of the gypsum in different directions and not to radiation from the wire.

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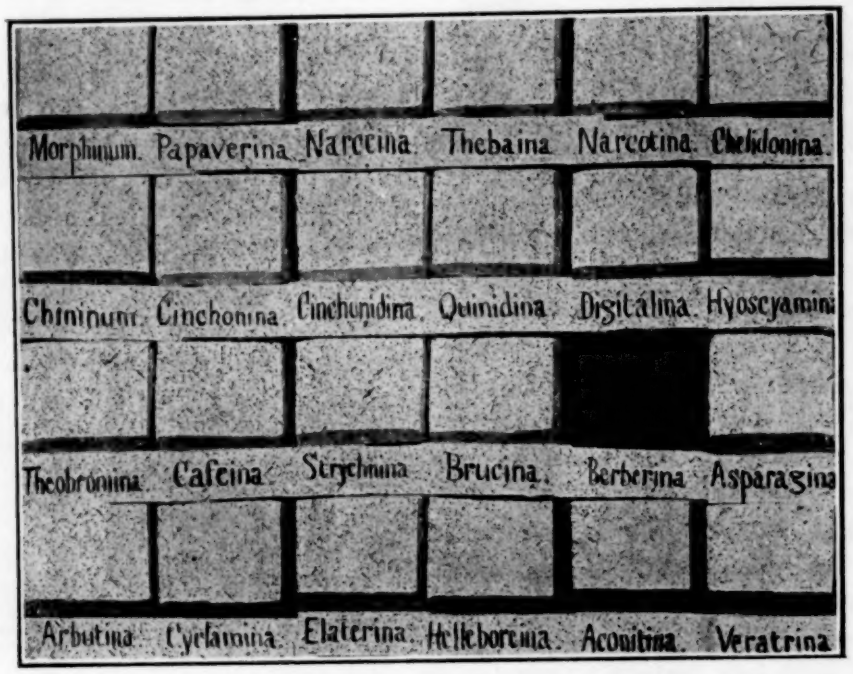
SOME CURIOUS CASES OF SELECTIVE REFLECTION IN ULTRAVIOLET LIGHT

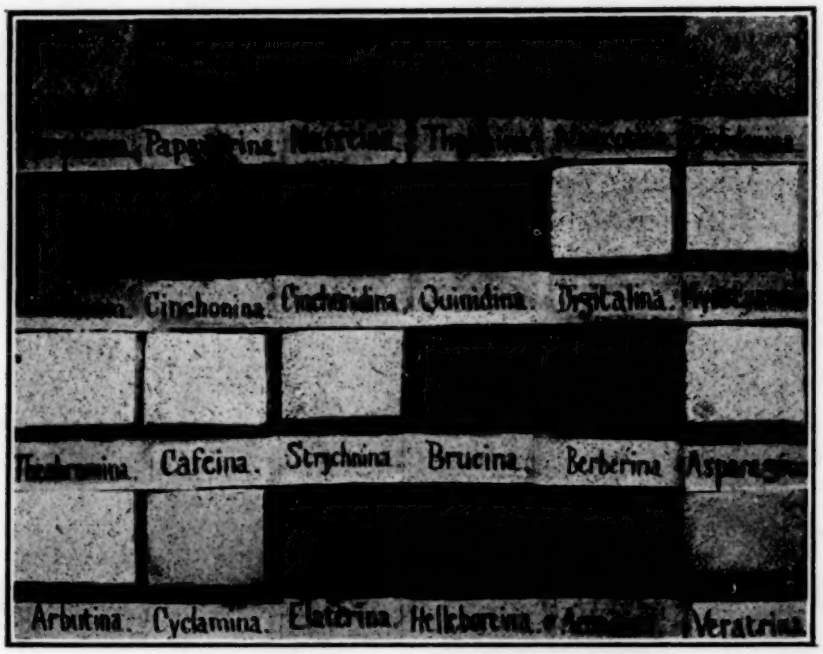
PROFESSOR WOODS, of Johns Hopkins University, has found that some white flowers, when photographed in ultraviolet light, appeared as black or nearly so. This fact led the writer to examine the behavior, in such circumstances, of a number of alkaloids, glucosids and other vegetable immediate principles he happened to have on hand. The result is shown on the two accompanying figures. Photograph number I. was taken with an ordinary objective. Number II. is a photograph of the very same substances taken with a quartz convex meniscus, silvered on both faces and completely opaque to visible light. The 24 substances had been previously powdered and somewhat compressed into their respective boxes. As the ordinary photograph shows, they were, with but one exception (berberin) perfectly white. Photograph number II. shows that, if our eye were sensitive

to ultraviolet light, about two thirds of these white substances, when immerged in such light, would appear to us as black or dark gray. As a rule inorganic compounds do not seem to behave in such an extraordinary manner. Excepting zinc oxyde which, as Professor Wood has shown, powerfully absorbs ultraviolet light, and bismuth sub-nitrate which, as the writer and Professor Tristan have found, reflects but little more ultraviolet light than zinc oxide, most inorganic compounds reflect ultraviolet light about as they reflect ordinary light.

The writer was unable to find any constant relation between the chemical constitution or physical properties of the 24 substances and their selective reflection for ultraviolet light.

The tremendous differences shown on the two photographs will probably one day find some application to analytical chemistry.


Morphinum. Papaverina. Narceina. Thebaina. Narcotina. Chelidonina.
Chininum. Cinchonina. Cinchonidina. Quinidina. Digitalina. Hyoscyamin
Theobromina. Cafeina. Strychnina. Brucina. Berberina. Asparagin
Arbutina. Cyclamina. Elaterina. Helleborcina. Aconitina. Veratrina.



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